Annual Progress Report
of the
Massachusetts Division of Marine Fisheries
Eelgrass Restoration Project

Period Covered:
July 1, 2005-June 30, 2006

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FY-06 Activities Update - Alison Leschen, Ross Kessler, and Bruce Estrella

Introduction:

The Massachusetts Division of Marine Fisheries (*MarineFisheries)* is conducting eelgrass restoration in Boston Harbor as partial mitigation for assumed impacts to the environment and biota from the construction of the "HubLine" natural gas pipeline across Massachusetts Bay during 2002-2003. Restoration of eelgrass habitat will provide shelter, food, and has the potential to positively affect abundance of a number of finfish and invertebrate species which were determined to be impacted by pipeline construction activities which exceeded recommended time-of-year work windows. Among these species are a number of crustaceans, flounder, gadids, and anadromous fish. This work is intended to restore eelgrass habitat in order to improve abundance of finfish and invertebrate biota.

MarineFisheries Eelgrass Restoration Project efforts were initiated in spring 2004 with the acquisition of environmental data specific to Boston Harbor and development of a site-selection model (Estrella 2004). The site selection analysis used by Short et al. (2002) was modified and adapted to a GIS model.

MassGIS eelgrass areal coverage was overlaid on Massachusetts Bay nautical charts with town water boundaries to determine municipal responsibility for each meadow. The Program Coordinator contacted shellfish constables and conservation commissions from greater Boston Harbor area towns of Boston, Winthrop, Hull, Hingham, Weymouth, and Quincy regarding our intent to harvest and transplant submerged aquatic vegetation (SAV). All constables were called and their respective town conservation commissions received a letter of introduction, a description of work to be accomplished, and a request for input on local permitting guidelines and requirements.

By late summer 2004, project staff was hired and field work intensified. Estrella (2005) summarized the restoration work conducted through June 2005. During 2004 through December 2005, activities focused on permitting, site selection monitoring, test-transplanting, and initial larger-scale plantings. A review of available water quality databases for Boston Harbor helped in the process of selecting suitable sites for transplanting eelgrass, particularly when these data were augmented by on-site monitoring of pertinent environmental parameters by project personnel. The site-selection model is based on a grid of 100m square cells covering the Boston Harbor area. Seven parameters were estimated at each cell: depth, exposure, historical SAV distribution, current SAV distribution, water quality, bioturbation, and sediment type. Parameters were assigned scores based on their value and each cell was color-coded to reflect the scores which allowed mapping of the indices.

As described in the previous progress report (Estrella 2005), 12 sites were selected for primary phase test transplanting. Site selection was based on existing environmental data, field observations (use, true depth), and sampling (sediment cores). Four TERFs™ (weighted wire mesh frames to which eelgrass shoots are tied) were deployed with 200 eelgrass shoots (50 per TERF™) at each site (Figure 1).

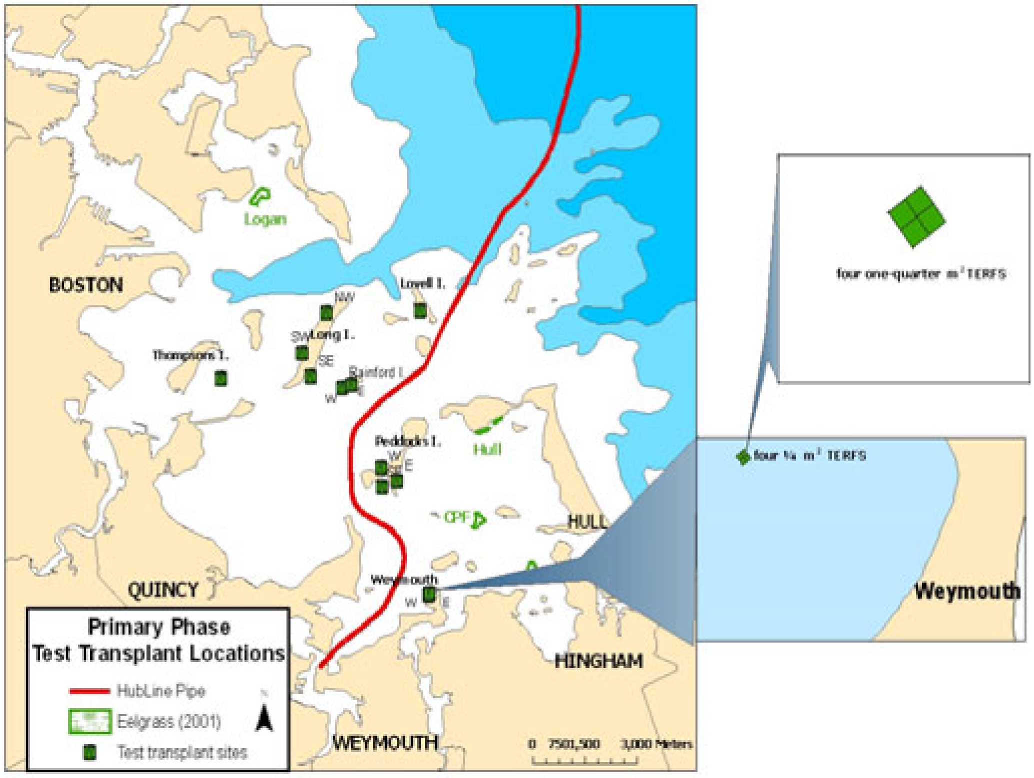


Figure 1. Primary phase test transplant locations in Boston Harbor, 2005. Each of the 12 Sites was planted using four wire TERF™ frames arranged in a square; each had 50 eelgrass Shoots attached. There are two sites at Rainford Island and Weymouth (they appear as one on the map due to their proximity). Logan, Hull and CPF (Crow Point Flats) are pre-existing, natural eelgrass bed remnants, last surveyed and mapped by MA DEP in 2001.

<u>Activities Update:</u>

The initial 12 test transplantings were monitored for shoot survival and general health. Four of the best sites, NW and SW Long Island, Peddocks SE, and Weymouth (two Weymouth sites were combined into one) were chosen for medium-scale transplanting (Figure 2). Of the remaining seven, four were found to have sediment unsuitable for eelgrass (either too rocky, too fine, or anoxic). One site was eliminated due to excessive weekend boat traffic and anchoring, which had not been apparent in our regular weekday visits to the Harbor. The other two sites were monitored during summer 2005 and may be planted in the future.

The four selected sites were planted with 1000 eelgrass shoots using various methods and configurations in order to test their effectiveness. These were planted along a 50 m transect as depicted in Figure 2 and included wire TERFs™ (50 shoots tied per TERF™) planted singly, in a square pattern, and offset. Also, 1 m^2 quadrats were hand-planted and new TERF™ alternatives constructed with PVC frames were tested (Figure 3). These were developed as a lighter-weight alternative to the heavier wire mesh TERFs™ which were cumbersome for divers. Pairs of eelgrass shoots were tied at each of 25 junctions of the jute and 10” spikes were driven through pre-drilled holes in the frame corners to anchor the frame in the sediment; metal landscape staples were used to anchor the jute. After the eelgrass has rooted, the jute can be cut away along the inside of frame and left behind to biodegrade; frames and spikes are retrieved for reuse.

The four secondary phase transplant sites were monitored over the summer for survival and overall health of eelgrass shoots and all fared well. Three sites were chosen for larger-scale plantings in fall 2005; a fourth was planted in spring 2006. The PVC or "string frames" fared well in test deployments.

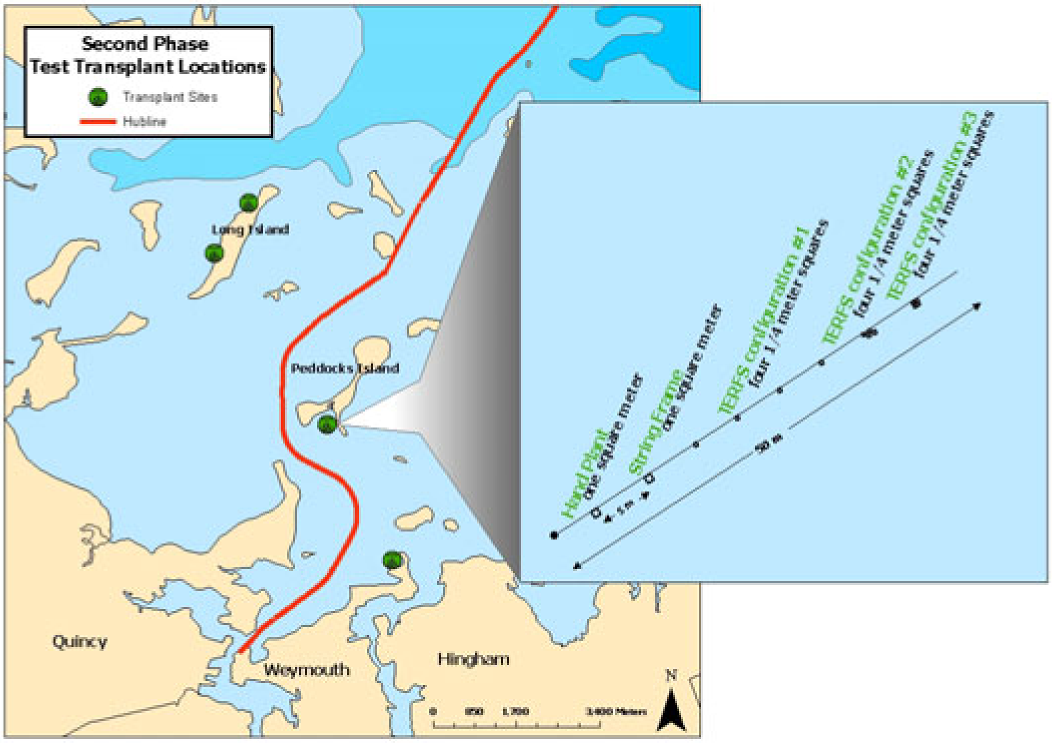


Figure 2. Secondary Phase test transplants in Boston Harbor, 2005. Each site was planted with 1000 shoots in different patterns by different methods.

Figure 3. A PVC frame/jute mesh structure (string frame) was constructed as a lighter-weight alternative to TERFs™.

Seventy-two hundred shoots were planted in a one-acre area at the SW Long Island site where the sediment was sandiest. Half of the area was planted with string frames and the other half was hand-planted. Only hand-planting was done at the Peddocks Island site due to its gravel substrate which made string frames impractical as they would not rest flat on the bottom. In Weymouth, finer sediment affected visibility and made hand-planting difficult so only string frames were used there. Thirty-six hundred shoots were planted at Weymouth and also at Peddocks SE for a total 14,400 shoots planted during 2005.

Harvesting off Nahant and large-scale plantings continued into spring 2006. Four plantings totaling 13,800 shoots were conducted at three sites, Portugese Cove (Peddocks W; 6700), Long Island NW (4600), and Long Island SW (2500) during May/June 2006.

Shoots for transplanting were harvested from donor beds off Nahant. Monitoring of harvest vs. control transects indicated no detrimental effect from harvest on shoot density. Flowering shoots were also harvested from this area for seed production. The seed shoots were kept in a flow-through seawater tank at the Marine Biological Laboratory in Woods Hole until the seeds ripened and dropped from the leaves. Approximately 300,000 seeds were collected and distributed at three sites to complement shoot planting.

Volunteers continued to be a mainstay of the program. Seventeen divers and 95 shore helpers contributed 305 volunteer-hours of work. Other outreach efforts continued with presentations and work with students at schools. Volunteer field assistance was provided by several groups on three additional occasions in spring 2006.

Evaluation of Plantings:

In fall of 2005, eelgrass at Long and Peddocks Islands sites looked generally good to excellent. The "string" frames used in some plantings were performing well; all held fast and most of the jute had been silted over, burying the rhizomes and holding the shoots in place. The Weymouth site was questionable, because plantings from earlier in the year began looking very unhealthy by fall. We had hoped to retain this site as it is the only remaining one along the mainland. All remaining sites are around islands and thus accessible only by boat. Most of the rest of the Boston Harbor coastline has been eliminated due to depth, sediment type, or human-use limitations.

In spring of 2006, seven of the original 12 test transplant sites, which included the secondary and full-scale planted sites, were monitored for survival. The other 5 had already been eliminated. Survival of shoots was observed at all locations and eelgrass appeared healthy and is spreading. The hand-planted sites looked the best, are free of macroalgae, and are thriving. The PVC "string" frames worked much better than the wire mesh TERFs™ and were fairly easy to retrieve without damaging eelgrass plants, although the jute seemed to collect macroalgae. Nevertheless, the grass looked very healthy. A rough calculation of shoot density at the Peddocks Island site was 370 shoots m^2 and 100% expansion (the area effectively doubled) and the Long Island site density was 274 shoots m^2 with 50% areal expansion. The Weymouth site continues to look unhealthy and sparse. This site may be abandoned in lieu of Peddocks W.

Seeds planted in fall 2005 began sprouting, however, preliminary germination rate counts are low (around 1%). All areas will be formally surveyed to record survival and expansion during 2006. A biological monitoring plan was developed and initiated to investigate species number and composition at existing, planted, and control sites.

Preliminary Transplant Suitability Index:

A significant amount of work was done on refining the preliminary transplant suitability index (PTSI). PTSI model output and the resulting map effectively focused the search for suitable sites, thus reducing the number of areas targeted for further investigation. Sites that scored well on the PTSI index (preliminary transplant suitability index) received “groundtruthing.” As a result, large areas of potentially suitable bottom that had shown up on the original site selection map were eliminated due to subsequent field observations and testing (Figure 4).

Reasons for elimination of potential planting sites included unsuitable use (marinas), depth (differing from navigational charts, either too shallow or too deep), exposure, and sediment types (too rocky or muddy). Inappropriate sediment is one of the biggest impediments to site selection for eelgrass restoration.

Figure 4. PTSI (Preliminary Transplant Suitability Index) scoring of restoration area; color-shaded areas near shoreline indicate a non-zero score and potential planting sites.

The initial PTSI model's sediment data input was a polygon layer of sediment types for Massachusetts Bay developed by the USGS (Knebel 1993). The percent composition of each sediment type was determined for each grid cell in the model and the predominant sediment type for each cell was then used to derive a score for the sediment parameter. However, the USGS map of sediment was insufficiently accurate at the shallow depths which we were investigating. It defined soil types based on extrapolations from deeper water, consequently, we ground-truthed the data layer by surveying sediment in the field by various methods.

During fall of 2004 through summer 2005, divers took sediment core samples. In 2005, sediment observations were enhanced with the acquisition of a Ponar grab sampler and an Atlantis underwater camera. With these tools we were able to quickly assess sediment in an area and thereby cover more ground. With the camera, rocky areas, which often also contained large amounts of kelp, could quickly be eliminated. Black, anoxic areas could be omitted by using the grab sampler. If the sediment did not show obvious problems, a core sample was obtained via SCUBA for further evaluation and analyzed for grain size.

Procedures for taking, storing, and processing sediment core samples were defined. Sediment cores were collected and bioturbators such as green crabs and skates were counted along 2 to 3, 50m transects per site (2m swath per transect). Sediment samples were dried and sieved to determine composition by grain size and associated weight.

Sediment grain size obtained at many sites was very fine (silt and clay) with apparent black anaerobic mud below ~2 cm, likely the result of years of deposition of organic matter from formerly active outfalls within the Harbor, and therefore not conducive to eelgrass survival (Koch 2001, Goodman et al. 1995). These observations of possible anoxic sediments in some areas raised concerns about bottom sediment quality. This type of sediment can subject eelgrass to H_2S toxicity (Barko and Smart 1983, Carlson et al. 1994, Koch 2001, Goodman et al. 2005). In addition to the potentially toxic effects of anoxic, sulfide-rich sediment, depositional matter is easily re-suspended by wave and (vessel) wake action. Suspended particles in the water column reduce the amount of light that reaches the bottom, shading out eelgrass. As a result, laboratory analyses of total organic carbon (TOC) and pore water sulfide were contracted to help refine the transplant site selection process. Figure 5 shows the areas where sediment was sampled, and reasons for elimination of sites.

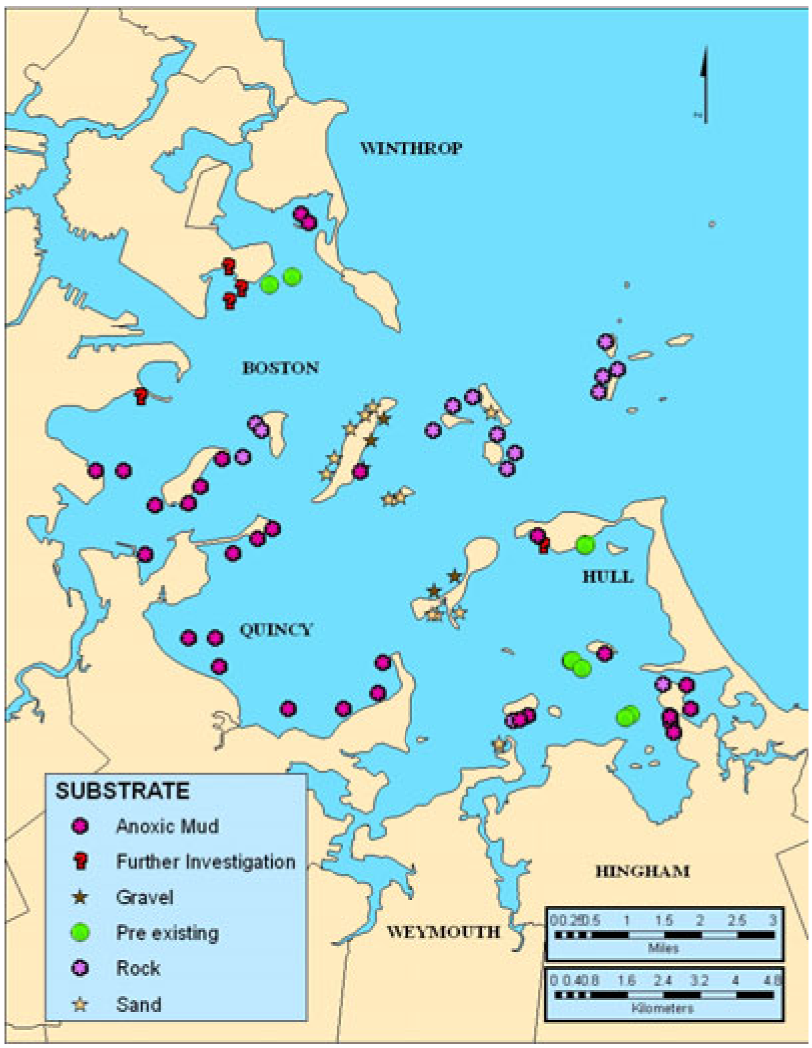


Figure 5. Areas where substrate was examined by camera, Ponar grab, or core sample. "Pre-existing" refers to existing eelgrass beds. Areas denoted as "Further Investigation" will be explored further in 2006.

Core samples from Primary Phase test transplant sites (Figure 1) were analyzed for grain size composition by project staff, and for Total Organic Carbon (TOC) and pore water sulfide levels (at the University of Massachusetts, Boston). Results from test transplant sites were compared to existing eelgrass beds, as well as to literature values to determine suitability.

Sediment in existing beds was largely sand (Figure 6). Sites that were eliminated based on sediment composition through both grain size analysis results and from field observations were: Lovell, Rainford E and Peddocks E (too much pebble), and Thompson (too much silt/clay). Weymouth E and W were combined into one site. The second Rainford site was eliminated due to heavy boat traffic, despite excellent sediment. Secondary transplants were conducted during 2005 at Primary Phase sites which yielded the best results. Of the remaining sites, those that were not planted in 2005 will receive further test transplants and possible large-scale plantings in 2006/7 (e.g., SE Long I). Peddocks W (Portugese Cove) and NW Long I are already receiving additional plantings in 2006.

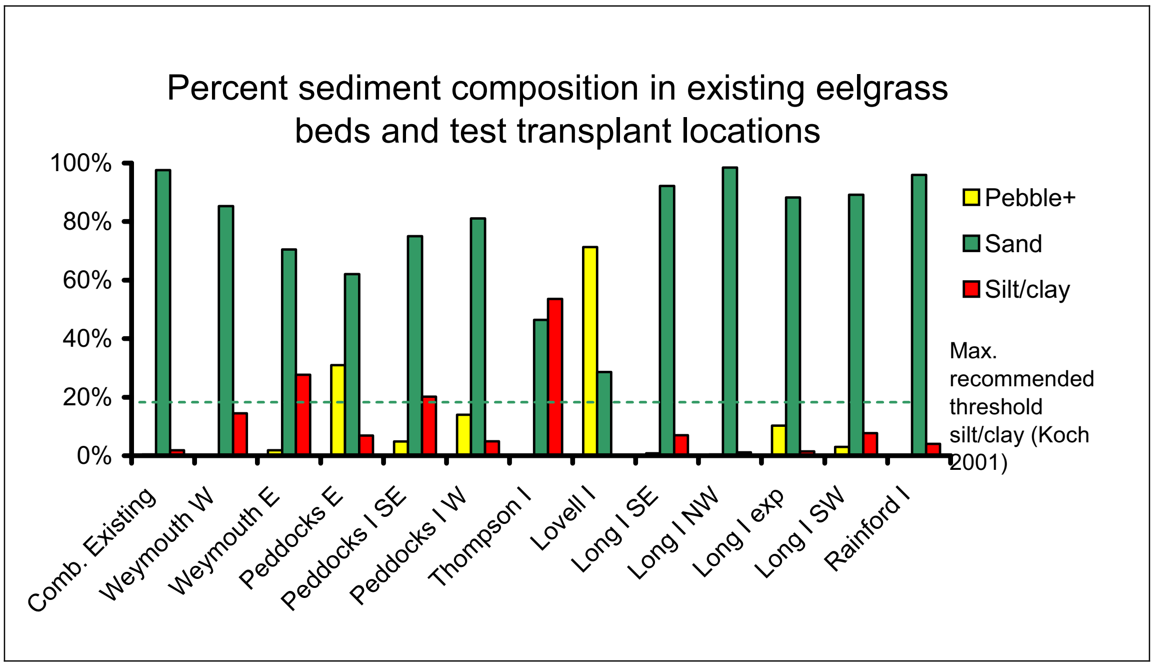
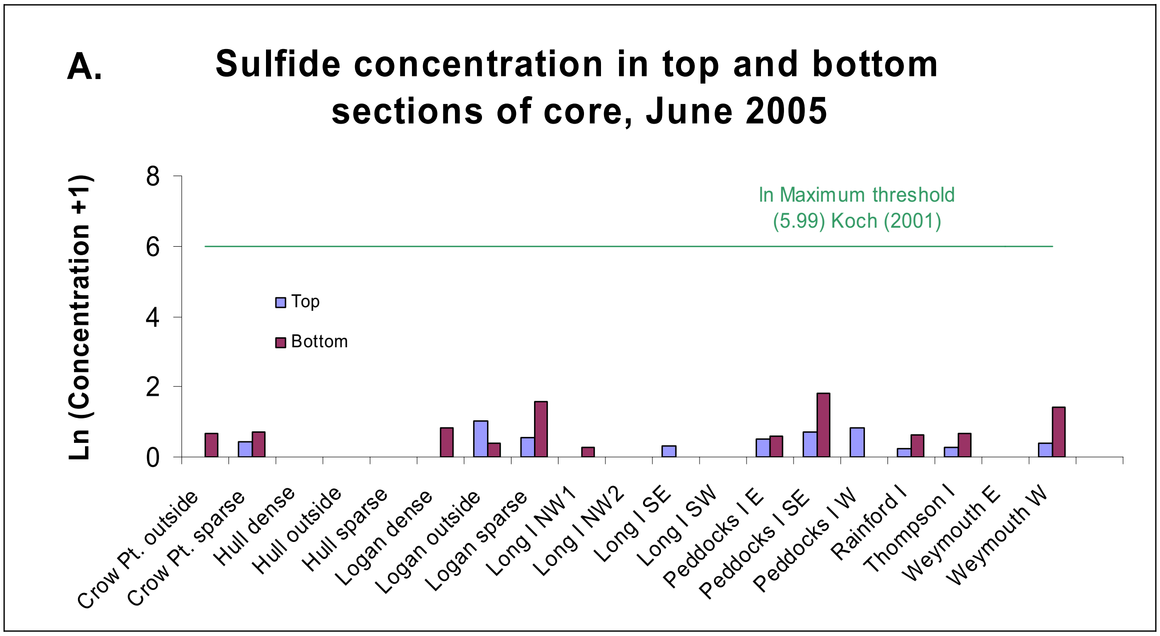


Figure 6. Percent sediment grain size composition at each site. "Pebble+" = grain size >4 mm. "Sand" = 0.063-4 mm. "Silt/Clay" = < 0.063 mm. Koch (2001) does not recommend planting where silt/clay exceeds 20% of sediment (dashed line). Significant large grain size (Pebble+) is also counter-indicated. "Combined Existing" are the mean values for the Logan, Hull, Crow Pt., and Hingham beds.

Potential transplant sites were not eliminated soley on the basis of pore water sulfide (Figures 7A and 7B) and TOC (Figures 8A and 8B) data. Koch (2001) recommends avoiding transplant sites where sulfide levels exceed 400 µM (ln = 5.99). Data collected in June 2005 indicated relatively low levels of sulfide (Figure 7A), but September 2005 data were higher (Figure 7B). Nevertheless, all potential sites fell below the threshold level except September data at "Logan sparse", an existing bed.



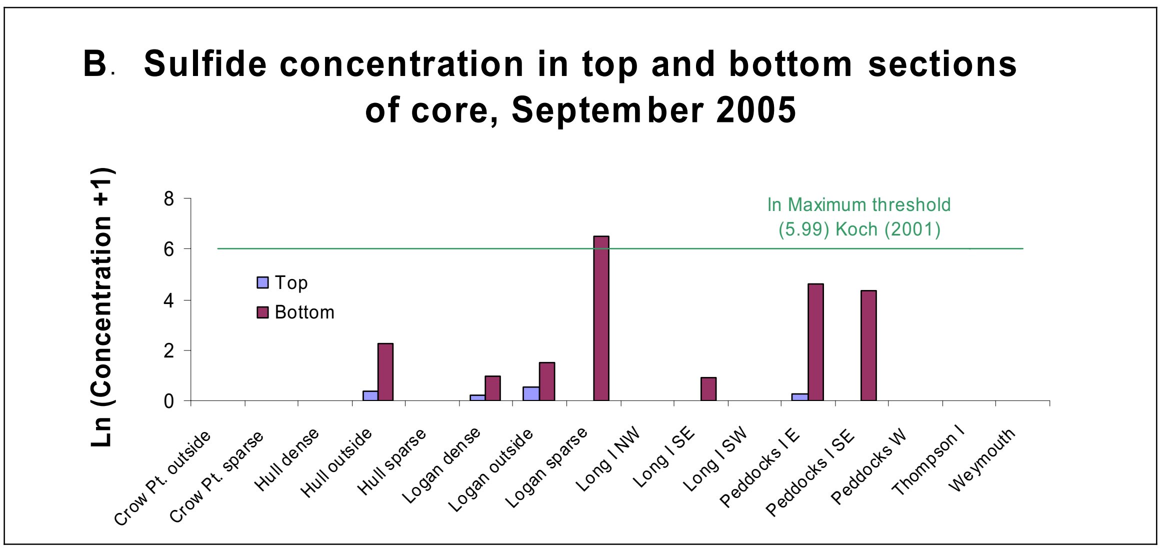
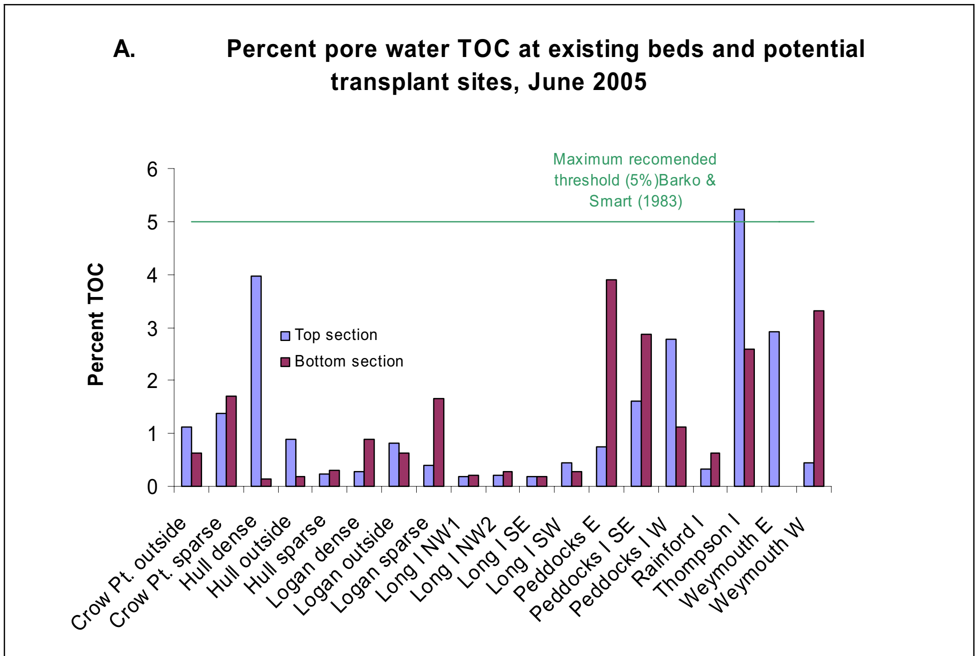


Figure 7. Porewater sulfide concentrations (converted to ln due to the wide range of data values (0-654)) at existing eelgrass beds and potential transplant sites in Boston Harbor in June (7A) and September (7B) 2005. In existing beds, "dense" and "sparse" refer to a dense, central part of the bed and the sparse edges, respectively. "Outside" refers to just beyond the boundary of the bed where there is no eelgrass. "Top section" refers to the top 5 cm of the core. "Bottom section" was the rest of the core, the length of which ranged from 9.4 - 17.5 cm due to collection techniques and sediment composition. Sites where concentration is zero either had too little porewater to test (typical of sandy/silty sediment) or tested below the detectable limit of sulfide, 0.21 µM. Where replicate samples produced anomalously high differences, the mean of the two values was graphed.

Barko and Smart (1983) recommended that percent TOC should not exceed 5%. TOC data collected in June (Figure 8A) and September (Figure 8B), 2005 was generally below that threshold except at Thompson Island in June. This was the only site to exceed this limit and it had already been eliminated due to its silty, black anoxic sediment composition, so this result was consistent with other site's data.



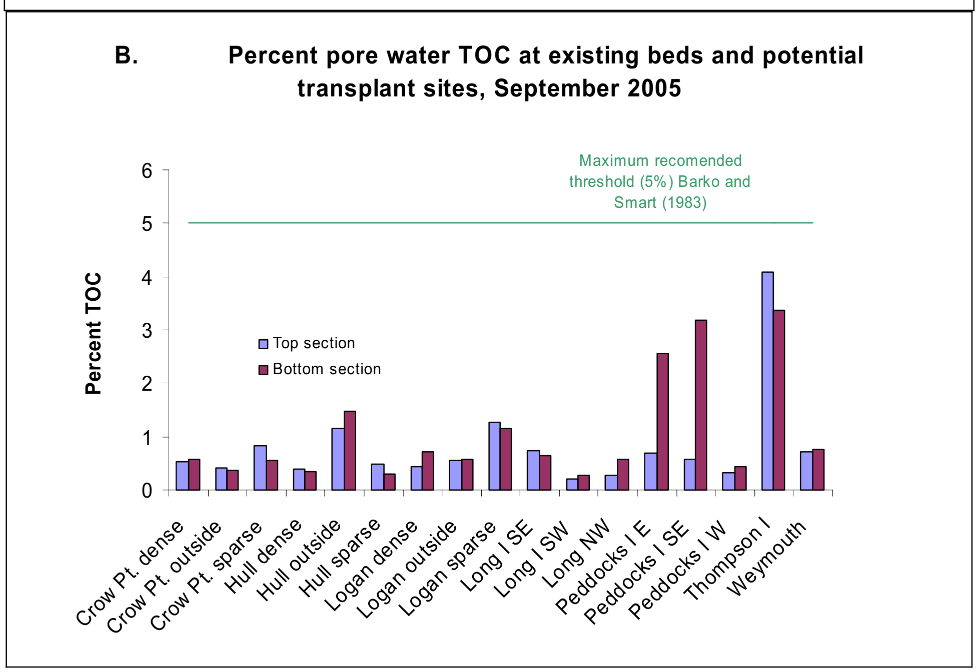


Figure 8. Percent Total Organic Carbon (TOC) at existing beds and potential transplant sites in Boston Harbor in June (8A) and September (8B) 2005. The length of the core from the Weymouth E site in June did not permit a bottom section analysis.

The laboratory tests did not yield additional information that was useful beyond sediment composition and field observations. Given the significant added expense for little return, it is unlikely that sediment chemistry testing will be continued in the future. Sulfide levels would be expected to be at their highest in September because of bacterial activity during the warmer months.

Harvest:

Harvesting of eelgrass began in Revere in spring 2005 (Figure 9). However, investigation of beds across the channel in Nahant showed that coverage there is much denser and more uniform. Nahant was subsequently adopted as the primary donor site.

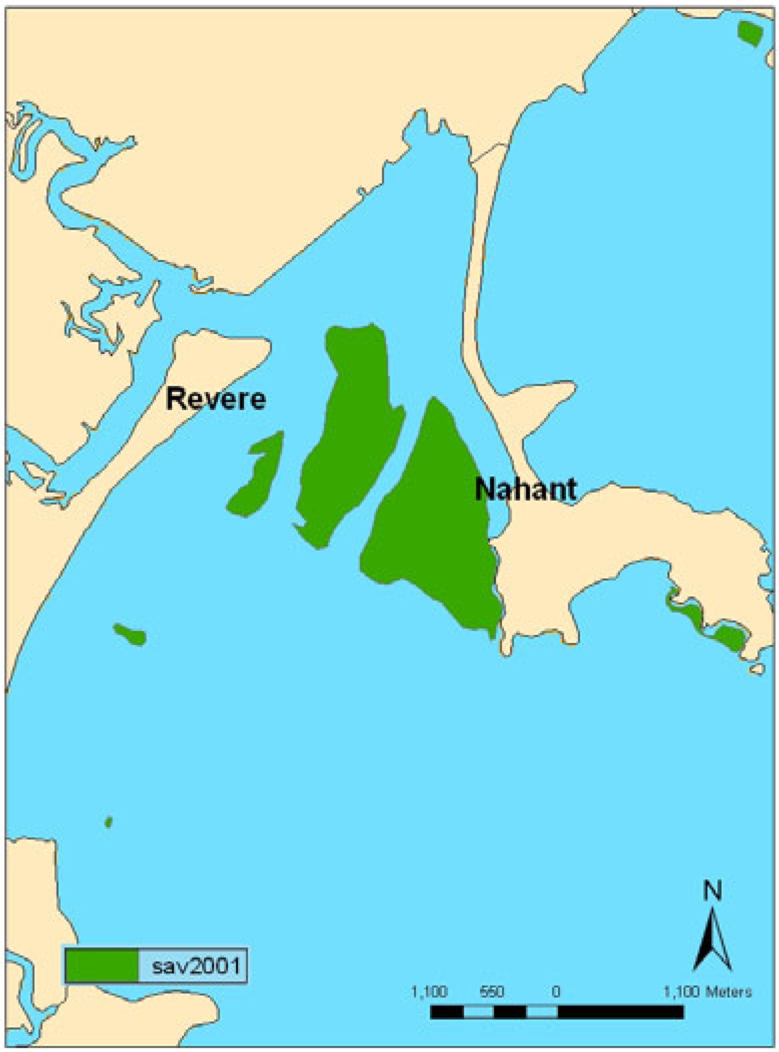


Figure 9. Donor beds in Revere and Nahant.

Permanent transects were laid where harvest occurred. Shoot counts were carried out in ten ¼ m quadrats along these transects and also along control transects (where no harvest occurred), approximately every two months to determine if harvest was having a long-term impact on the donor beds. Figure 10 shows shoot density in harvest and control areas at Revere (Figure 10A) and Nahant (Figure 10B). Differences are not significant ($p>.05$) in all comparisons of control vs. harvest on any date and location, suggesting that harvest had no detrimental impact on shoot density. Monitoring will continue in 2006.

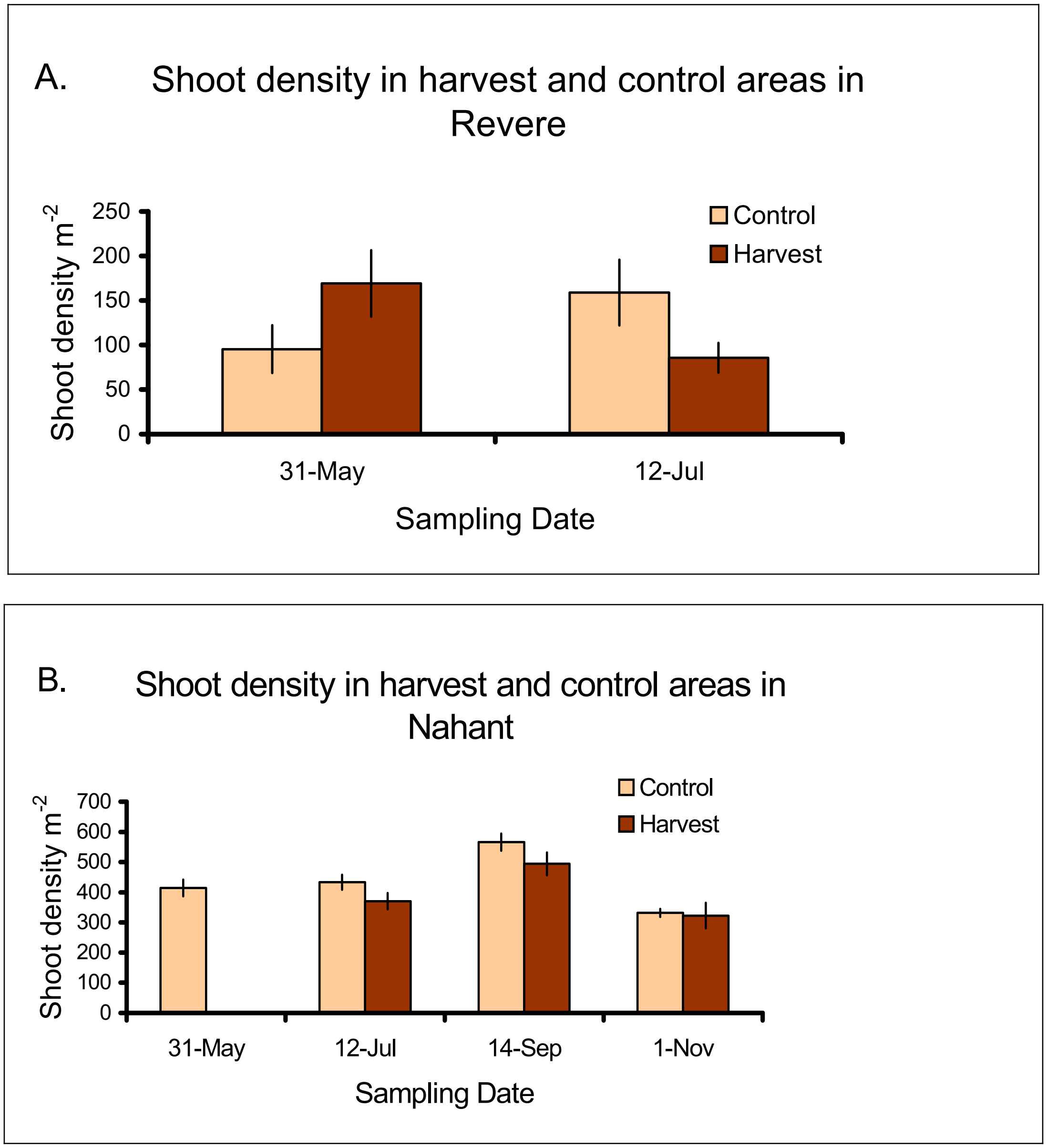


Figure 10. Eelgrass shoot densities at donor sites in Revere (IVA.10A) and Nahant (IVA.10B). Control and harvest data on each date were compared using a single-factor ANOVA . Error bars are +/- Standard Error. Revere was only sampled through July because shoot harvesting there ended after 31-May. A preliminary sampling was undertaken 31-May in Nahant to assess suitability for future harvests; there was no harvest on this date.

Preliminary Transplant Shoot Survival:

After the primary test transplant, shoot survival ranged from 5% - 90% (Table 1).

Table 1. Percent shoot survival after 6-8 weeks at primary transplant sites. An asterisk (*) indicates buoy was gone and TERFs™ were not recovered, but sediment was deemed unsuitable anyway.

SITE	% SHOOT SURVIVAL AFTER 6-8 WEEKS
Long I NW	50
Long I SW	45
Long I SE	75
Thompsons I	90
Rainford I	*
Rainford I E	87
Lovell I	5
Peddocks I (Portugese Cove)	45
Peddocks I SE	85
Peddocks I E	70
Weymouth E	95
Weymouth W	82

However, several factors besides shoot survival influenced the decision to continue planting at a site after both primary and secondary test transplantings. The Rainford E site appeared ideal for eelgrass growth, and in fact its test transplant fared very well. Unfortunately a weekend visit to the Harbor revealed that this cove is heavily used by recreational boaters. It is unlikely that eelgrass transplants could survive this amount of boat traffic and anchoring, so this site was reluctantly eliminated. Bottom type at the Rainford W site proved unsuitable; there were far more rocks and kelp than had been apparent on the initial visit. Survival at the Thompson Island site was high, however, the grass looked very unhealthy, was covered with epiphytes, and tore out very easily when TERFs™ were removed. Because of these factors, and the prevalence of extremely soft, fine, anoxic sediment, the Thompson Island site was eliminated. The site off Lovell Island turned out to be too shallow and too gravelly to support eelgrass. Despite these observations and mediocre survival rates at some of the Long Island sites, the remaining plants looked very healthy. There was a lot of excavation by crabs under the TERFs™ at Long Island and Peddocks Island SE sites. This excavation may have caused most of the mortality, rather than poor conditions for eelgrass. Further planting by alternative methods was therefore pursued at these sites.

In the secondary test transplant at four sites, combined shoot survival in the TERFs™ ranged from 54-67%. However, these numbers may be artificially low for two reasons. First, percent survival was based on a planned baseline of 50 shoots per 1/4 m^2 TERF™. However, a combination of bundler counting error, more or fewer than 50 shoots actually being tied to the frames, and loss of shoots between the tying stage and transport/placement of the TERFs™ on sediment, compromised the assumed baseline. To account for this problem, our baseline numbers are now counted during a survey within 2 weeks of deployment to determine the actual number of shoots planted. The initial survival estimates from test transplants are therefore more useful in relative rather than absolute terms. In future efforts, we intend to stress to volunteers who tie shoots the importance of exact counts to our data collection. Second, in general we found the hand planted shoots did much better than those in the TERFs™. Crabs excavated under the TERFs™, exposing roots, and when TERFs™ were retrieved, a number of shoots came with them.

The string frames showed potential; when they remained anchored, shoots did well, and looked healthier than those in the TERFs™. Hand planted squares, where excavation was not an issue, did very well. Evaluation and selection of final sites was therefore somewhat subjective, and based on health and vigor of remaining plants rather than strictly survival. It was felt that once equipment and techniques had been perfected, the secondary transplant locations would be most conducive to eelgrass growth.

The pattern in which TERFs™ were planted (Figure 2) appeared to have less effect on survival than the planting technique (i.e., hand plant vs. TERFs™ vs. "string frames"). There was no statistical difference in survival among the single, offset, and square patterns of TERFs™ except at Peddocks Island (Figure 11). Here the offset arrangement did poorly, but crab excavation was again an important factor in these results. A single-factor ANOVA was used to determine whether differences in survival were evident between planting patterns at each site. Such differences were not significant ($P > 0.05$) at any site except Peddocks Island, where the offset pattern displayed significantly poorer survival than the other two patterns ($p = 0.01$).

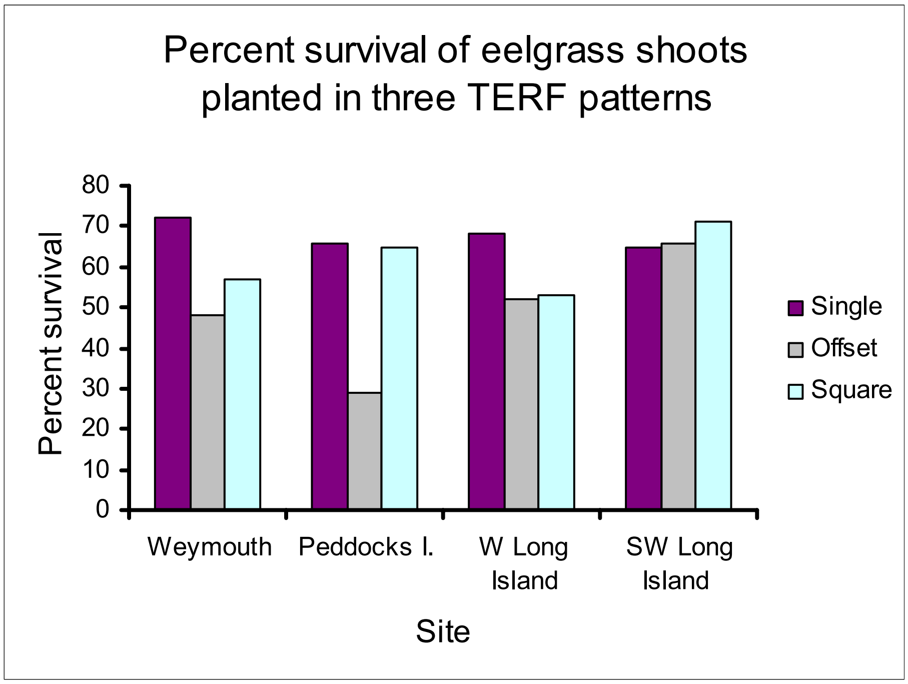


Figure 11. Percent survival of eelgrass shoots planted in various patterns at four sites in Boston Harbor, 2005. In the medium-scale test transplant, four TERFS™ were arranged in each of three patterns at four sites to assess the pattern's effect on survival. "Single" TERFs™ were placed linearly 5 m apart along a transect. "Offset" TERFS™ were laid in a checkerboard pattern. In the "square" pattern, 4 TERFS™ were laid adjacent to each other to form a square. N=12 at each site.

Final Site Planting Methods and Patterns:
Table 2 summarizes the decision process used to determine the final planting sites. Reasons for site elimination are provided. Some sites are left open to further investigation.

Table 2. Decision process used to determine the final planting sites during 2005.

#	DESCRIPTION	COMMENTS- END OF JUNE	PLANT FURTHER?	COMMENTS ON MEDIUM-SCALE PLANTINGS-AUGUST	PLANT FULL SCALE?	PRELIMINARY ASSESSMENTS - FALL
102	Upper NW Long	Macroalgae at start of summer, but looked good by end of June	**Yes. Medium-scale planting on 6-26-05**	Looks good: healthy new growth.	**Save for next year. Monitor algae, etc.**	
70	SW Long Island	Looking pretty good. Some excavation by crabs	**Yes. Medium-scale planting on 7-7-05**	Looks really good, especially handplant, but really everywhere where crabs haven't excavated	**Yes. 8-26-05, 3600 shoots, handplant. 9-24-05, 3600 shoots, stringframe. 10-5-05, seeds.**	Frames mostly good-excellent. Frames held in place. Roots, jute silted over. Grass looks really healthy, possible new growth.
78	SE Long Island	Lots of current. Crabs. < 30% remaining	No - not as good as others, but keep checking for possible future planting			
83	Thompsons Island	Lots of grass, but not healthy, TERFS ripped most out	No - high TOC, very mucky soil			
77	Rainford	Lots of kelp, etc. Bad site, eliminate	No - lots of kelp, rocks			
101 (81)	E Rainford	Looks great - TERFS ripping grass	No - heavy weekend boat traffic			
79	Lovells	Site no good: all gravel, too shallow	No - gravel. Poor site			
71	Portugese Cove, Peddocks	Fair - some grass but not much. Lots of crabs	No - looks poor, but recheck for possible future.			
72	SE Peddocks	Looks great, healthy. Some pebbles - not great for TERFS, uneven. Excavation.	**Yes. Medium-scale planting on 6-26-05**	Plenty of grass - handplant looks good. Lots of crabs, excacvation under TERFS	**Yes. 8-25-05, 3600 shoots handplant. 10-5-05, seeds. Not good for string frames - too many rocks.**	Looks healthy. Sparser than Long Island - some prob. carried away in current, but remaining looks good. New growth. Fairly free of epiphytes.
80	E Peddocks	Looked terrible	No- not as good as 72. Recheck for possible future planting.			
84	Weymouth	Lots of grass, but epiphytes. Looks good.	**Yes. Medium-scale planting on 6-26-05 (84 & 85**	Handplant looks especially good, but all ok.	**Yes. 9-24-05, 3600 shoots, string frame only**	Frames: adequate.
85	Weymouth					

Organisms observed: Hermit, rock, jonah, green crabs; winter flounder; cunner; lobster; sculpin; ocean pout; Northern Pipefish; amphipods; shrimp; moonsnails; snails.

Once final sites had been selected, planting methods were decided upon. Both hand- planted squares and string frames were arranged in a checkerboard pattern by alternating eighteen planted and unplanted ¼ m^2 quadrats. The planted squares contained 50 shoots each. This pattern was adapted from a strategy used by Save the Bay in Rhode Island; it is designed to cover more ground than continuous planting of shoots, while providing voids for eelgrass to fill in. The Long Island site contains 8 of these grids, 4 each along two 150 m transects, bounding approximately one acre (Figure 12). The other two sites each contain 4 grids in a square pattern, and encompass a little under ½ acre per site.

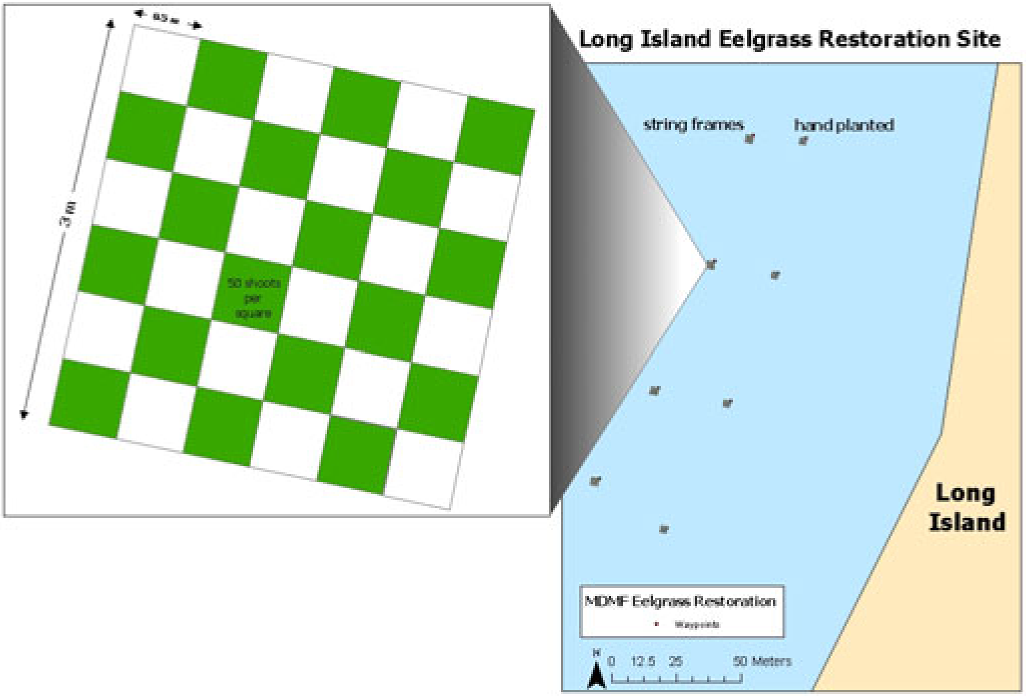


Figure 12 . Planting pattern showing alternating planted and unplanted ¼ m^2 quadrats. Total area bounded by buoys is approximately one acre.

<u>**Seed Harvesting and Planting:**</u>
Twelve fish totes of flowering shoots were harvested from Nahant in July. The shoots were delivered to flow-through seawater tanks at the Marine Biological Laboratory in Woods Hole. They remained there for approximately six weeks until seeds ripened and dropped out of the leaves. Thereafter, vegetation was discarded and seeds were collected and sorted from detritus using a series of sieves (Figure 13).

Figure 13. Clockwise from upper left: flowering shoots containing immature seeds; removing vegetation once seeds have dropped out; close-up of mature seeds; measuring seeds into bags for deployment.

Approximately 300,000 seeds were collected and nearly 270,000 were distributed at 2 sites in various densities on 5 October 2005. At each site, 1000, 2000, 3000, 4000, and 5000 seeds, respectively, were stirred into the sediment within the nine (1 m) squares of five, 3 m x 3m plots along a transect (Figure 14).

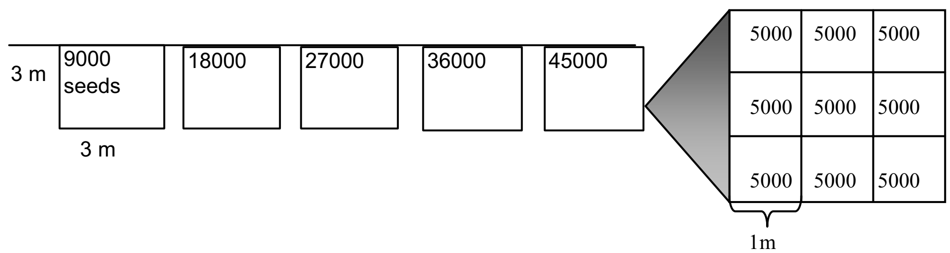


Figure 14. Layout of seed planting at different densities in each of five, 3 m x 3 m plots. Each plot's nine 1 m squares were planted with either 1000, 2000, 3000, 4000, or 5000 seeds for a total of 135,000 seeds at each of two sites.

The remaining 30,000 seeds were simply broadcast at the NW Long Island site. All of these sites will be checked in spring 2006 for germination and survival. Plots will be compared for differences in these two parameters by seed density in order to evaluate efficacy of the deliberate plantings vs. the less labor-intensive broadcast method.

Outreach:

Volunteers continue to be an essential part of the restoration effort. High school students from the BEAN program (Boston Environmental Ambassadors to the National Parks) assisted in the construction of the PVC string frames (Figure 15). Divers from the New England Aquarium, Save the Bay Rhode Island, and local dive clubs helped with harvest of flowering shoots for seeds and vegetative shoots for transplanting, hand-planting, and placement of string frames. Other shore helpers who tied shoots to frames (Figure 15) were from National Park Service, Single Volunteers of Boston, Norfolk County House of Corrections, New England Aquarium, Aimco Real Estate community service program, as well as some unaffiliated citizens. In all, 17 divers and 95 shore helpers contributed 305 man-hours to the project. Several additional volunteer events were held in May-June 2006.

Figure 15. Volunteers building PVC/jute frames (left), tying eelgrass shoots to PVC frames (middle) and diver hand-planting eelgrass (right).

MarineFisheries biologists gave presentations to the New England Aquarium staff, and to the public on a catamaran tour of the Harbor sponsored by the National Park Service as part of its Biodiversity Days. They also presented to the Quincy Beaches and Coastal Commission. The Odyssey High School GIS class completed its work using data from our research efforts and presented the results to the school. Members of the after-school program there completed the design of a logo which we now use on t-shirts supplied to all volunteers (Figure 16).

Figure 16. (Left) Single Volunteers of Boston model their t-shirts after a morning of tying eelgrass shoots to frames. (Right) T-shirt logo designed by Odyssey High School after-school participants.

The WHOI Sea Grant program working in inner-city Boston High School will be using seeds harvested by *MarineFisheries* in its "seagrasses in the classes" project. We are partners with TERC, a Boston inner-city after school program, on a grant application designed to enrich the program with hands-on Marine Science experiences for the children. If the grant is funded, we will be giving presentations to groups, and they will help tie eelgrass shoots and possibly with benthic and water quality monitoring.

The website, http://www.mass.gov/dfwele/dmf/programsandprojects/hubline/eelgrass.htm#hub, was last updated in November 2005. It will continue to be updated 2-3 times per year. Invitations from civic and environmental groups to present our project activities are always welcome. This report and subsequent annual reports will be provided to all participating towns, and any other interested parties.

Permitting:

All DEP permits are complete and Orders of Conditions were filed with all relevant County Registries of Deeds, thereby completing the process with the towns. The Army Corps of Engineers permit was also issued.

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Acknowledgements

Dr. Ryan Davis assisted in the collation and evaluation of available Boston area environmental data sets during year #1 of the Eelgrass Restoration Project. A formal, comprehensive GIS analysis of all data layers was developed and initiated with the help of *MarineFisheries* Research Analyst Micah Dean. Eelgrass Restoration Project field activities were assisted by members of DMF staff plus numerous volunteers. The National Park Service and Boston City Heath Department (Brian Dineen and Ed Winkowski) facilitated our use of Long Island as a staging area for shoreside work.